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(54) **RESIDENTIAL GATEWAY FOR VOICE OVER INTERNET PROTOCOL COMMUNICATIONS**

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**H04J 1/02** (2006.01)  
**H04M 11/00** (2006.01)

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USPC ..... **370/493**; 379/93.01

(58) **Field of Classification Search**  
None  
See application file for complete search history.

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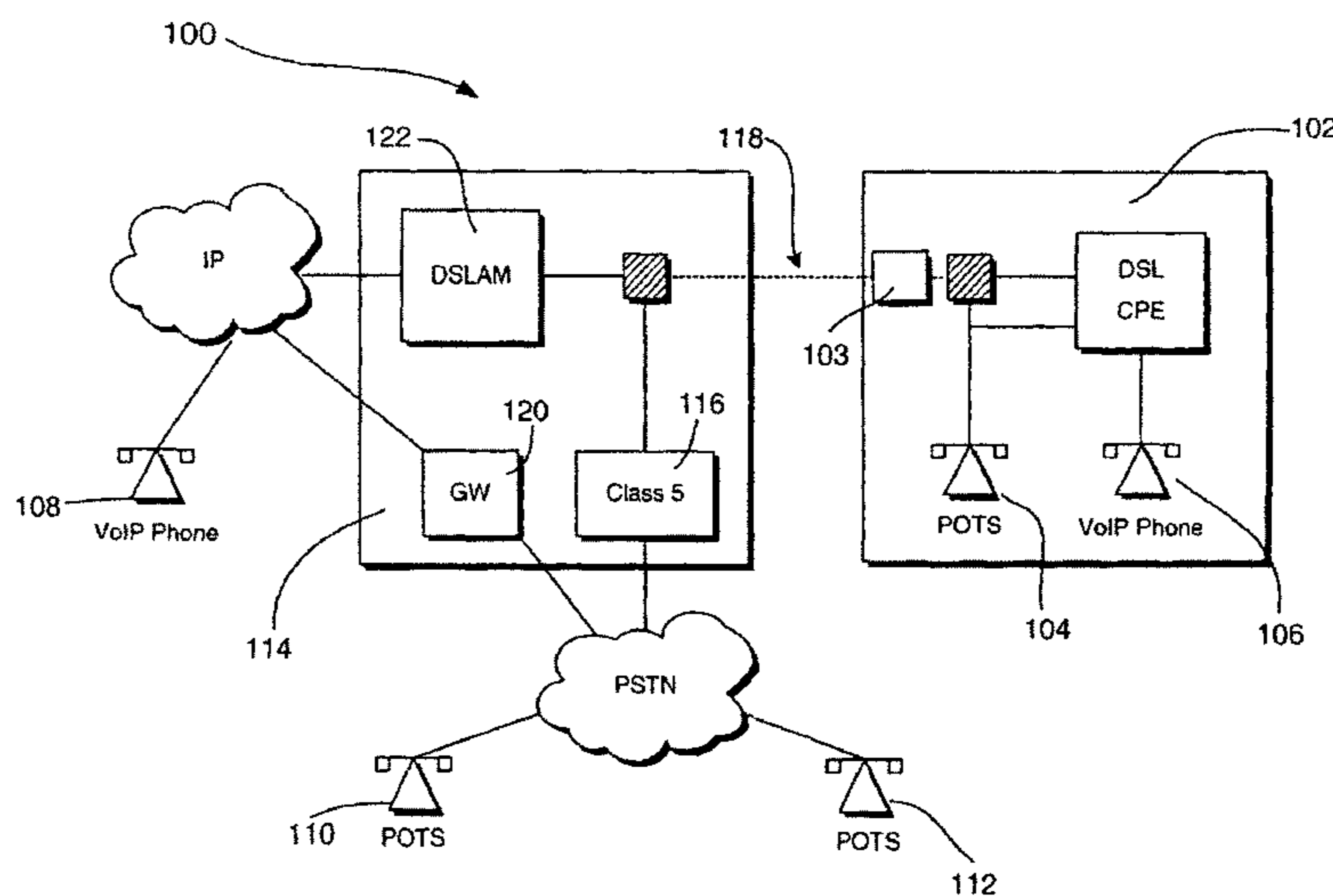
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(57) **ABSTRACT**

A method and system are provided for preventing data loss in a VoIP system. In particular, during a VoIP call, it is determined whether incoming ringing on a POTS line causes an unacceptable level of signal loss or errors. If so, for subsequent VoIP calls, the CO handling calls to the POTS line is instructed to either answer each call with a busy signal or automatically forward calls to the POTS line to the VoIP line or other selected telephone. Calling returns to normal upon ending of the VoIP call. In this manner, incoming ringing on the POTS line does not result in call dropping or lengthy retraining processes.

**19 Claims, 4 Drawing Sheets**



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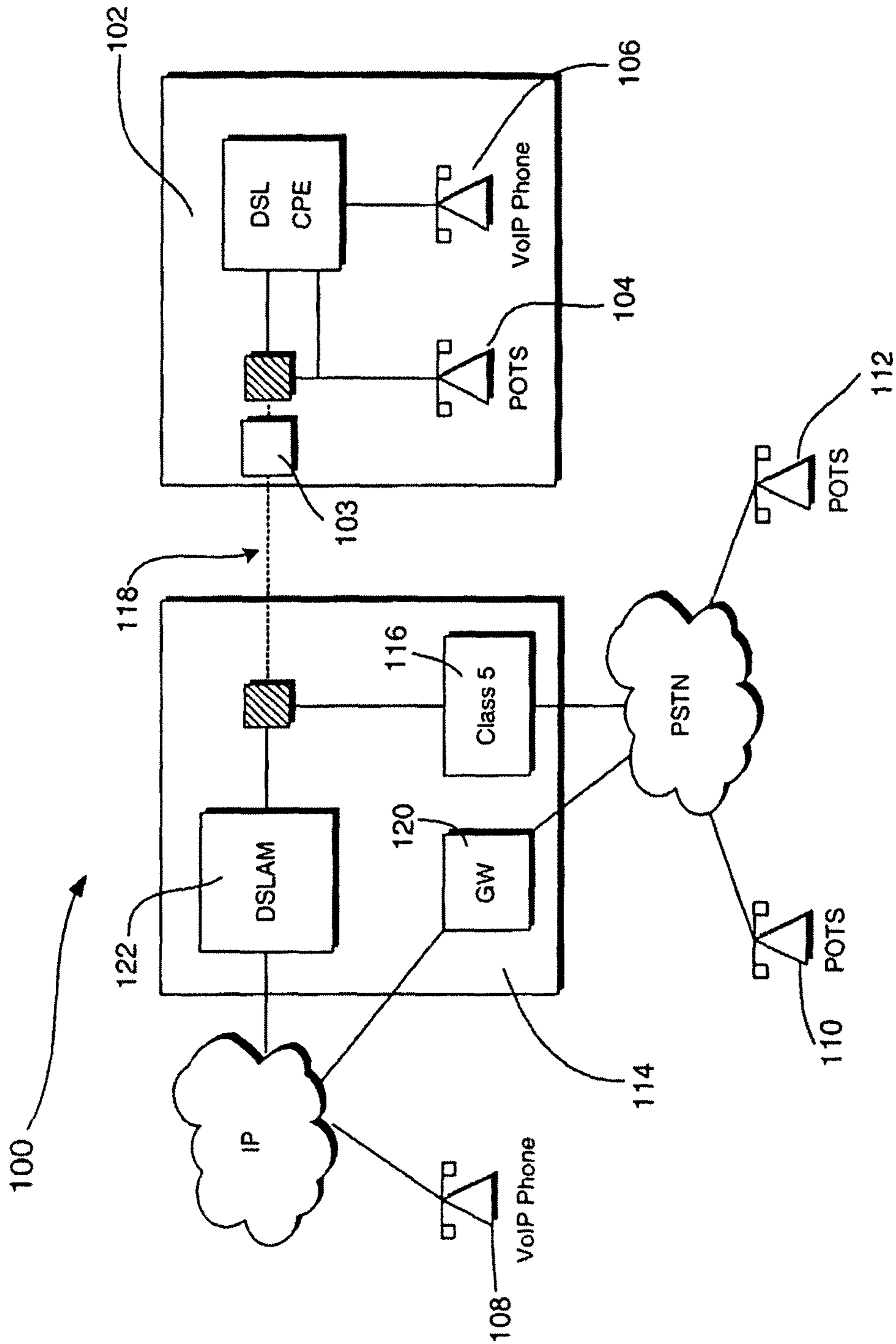


FIG. 1

FIG. 2

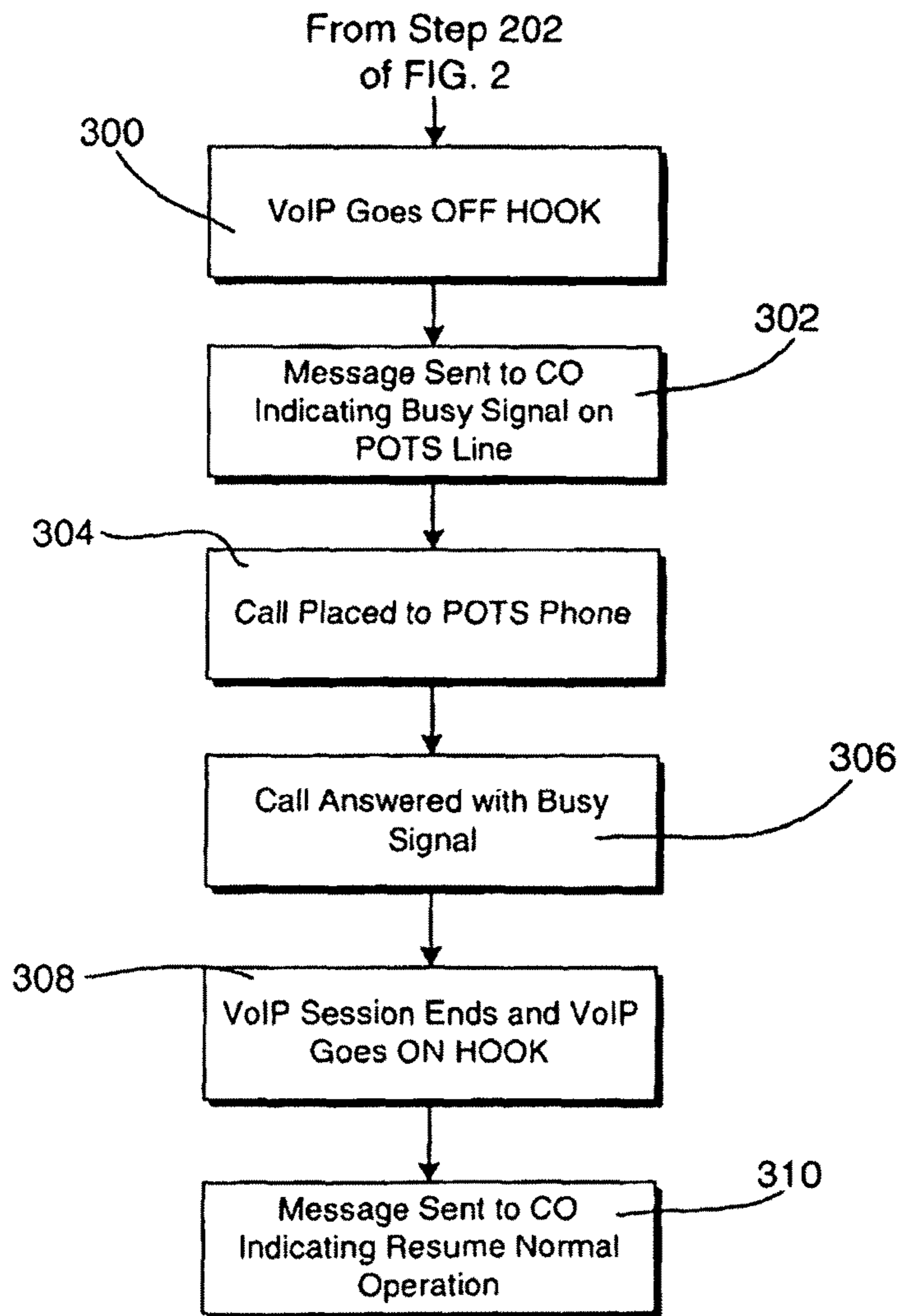
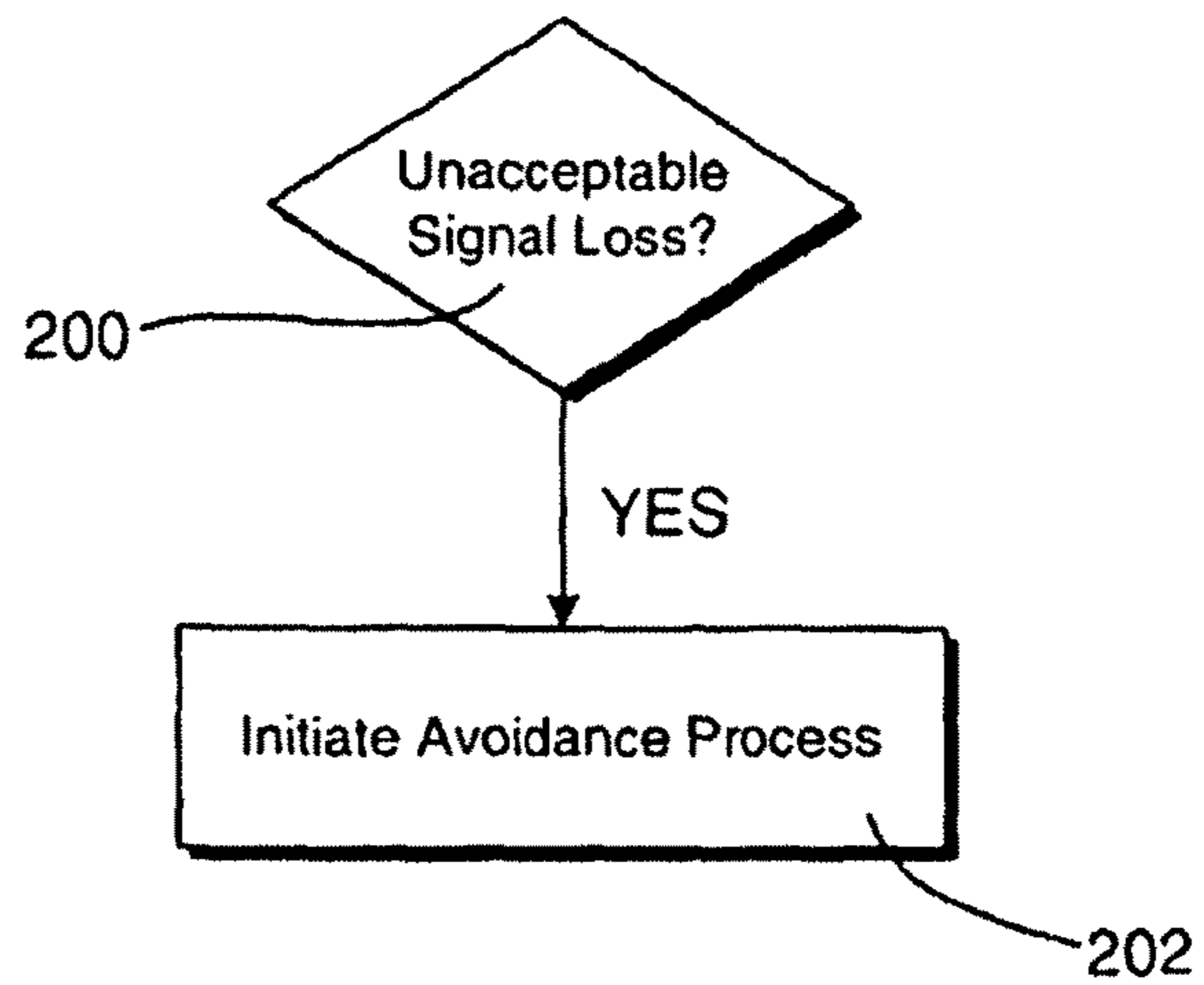


FIG. 3

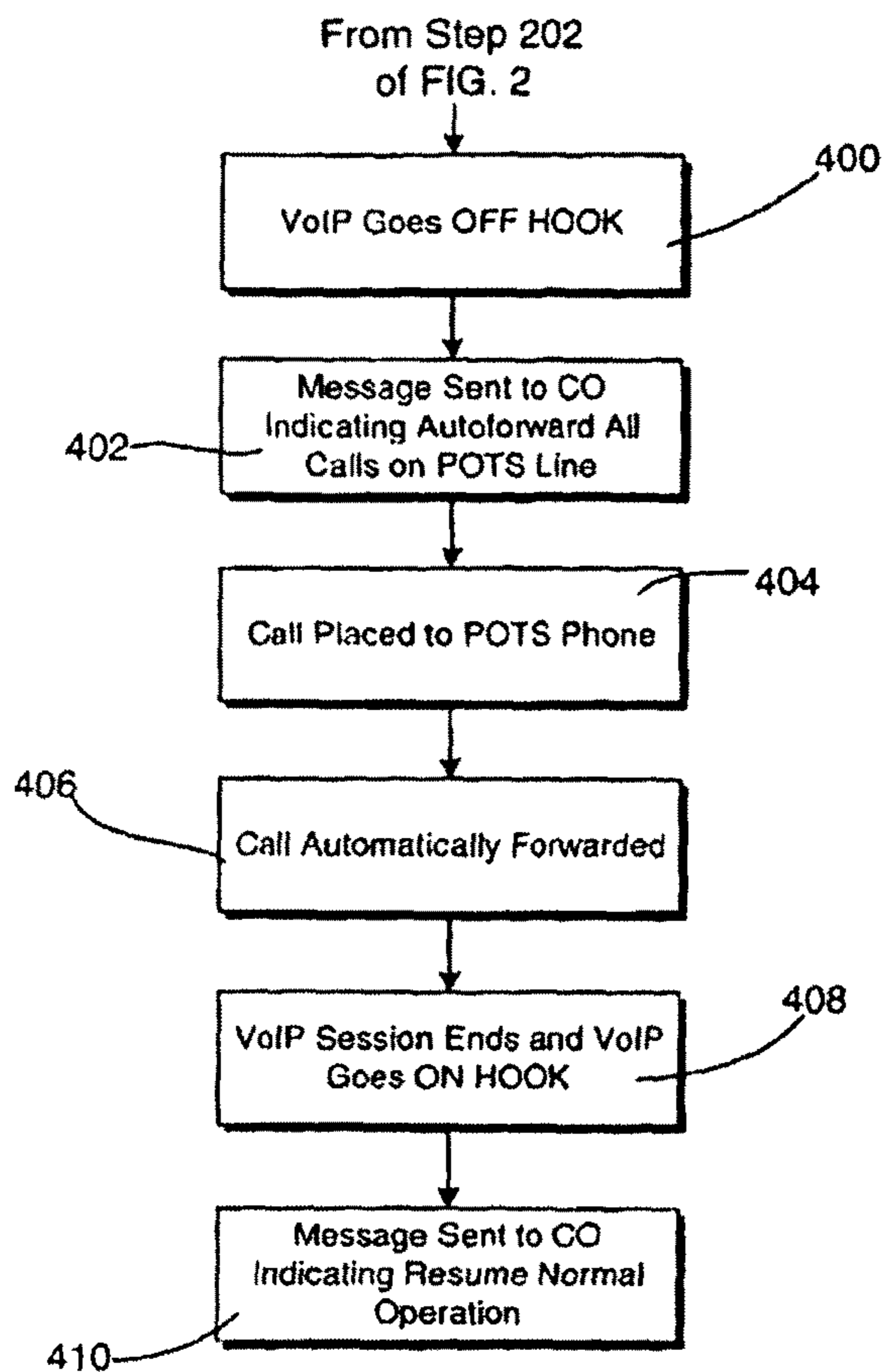


FIG. 4

FIG. 5

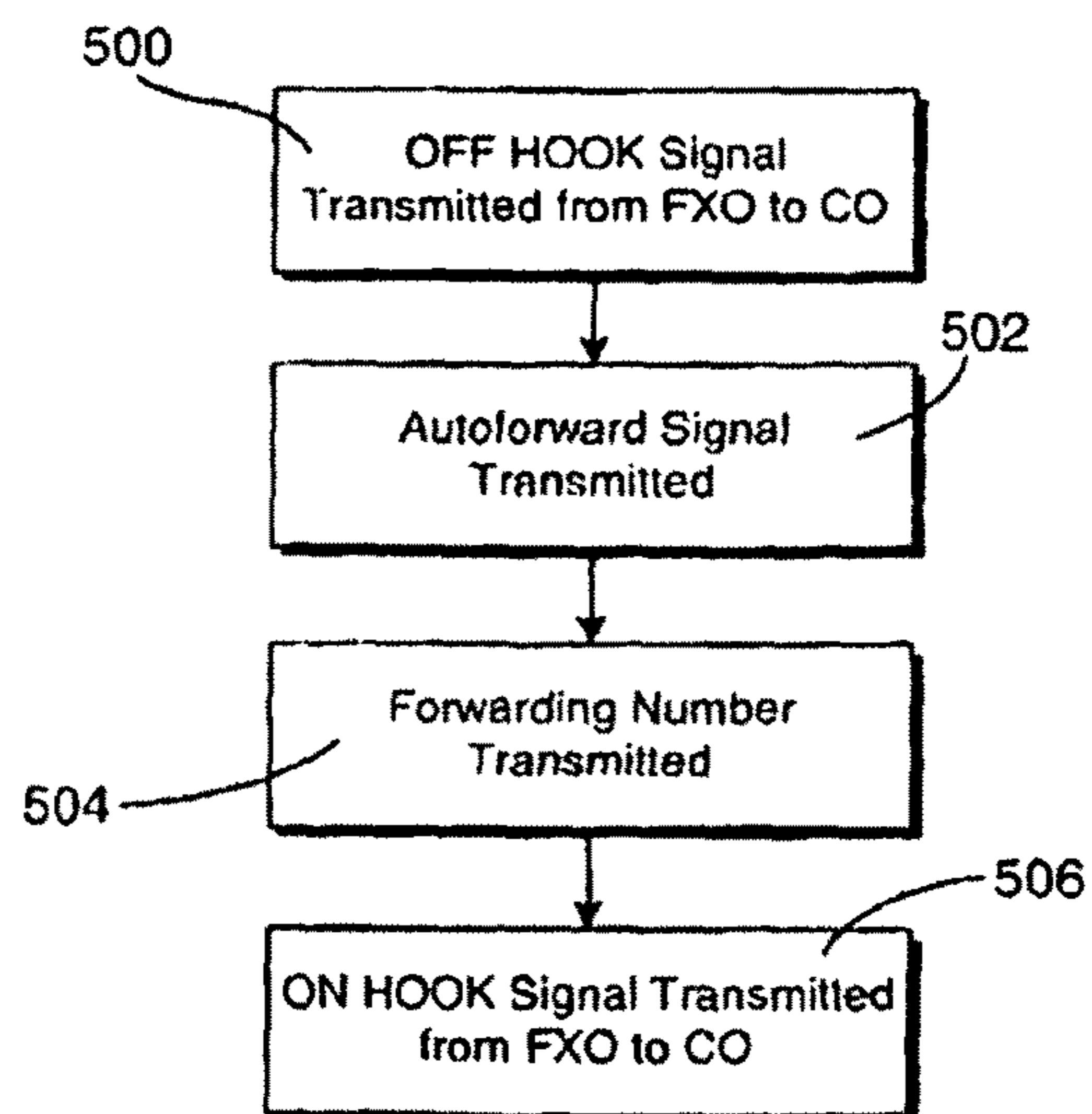


FIG. 6

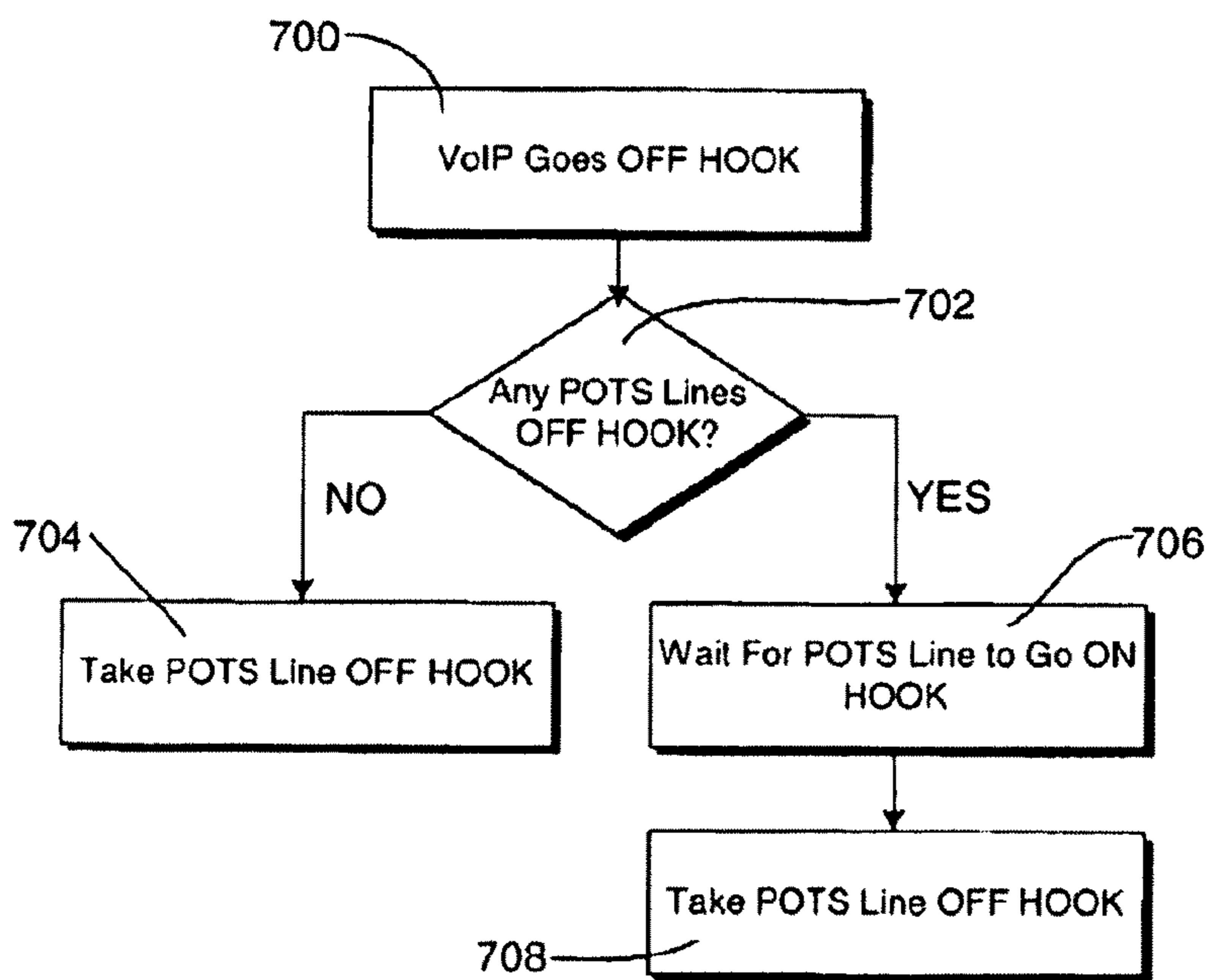
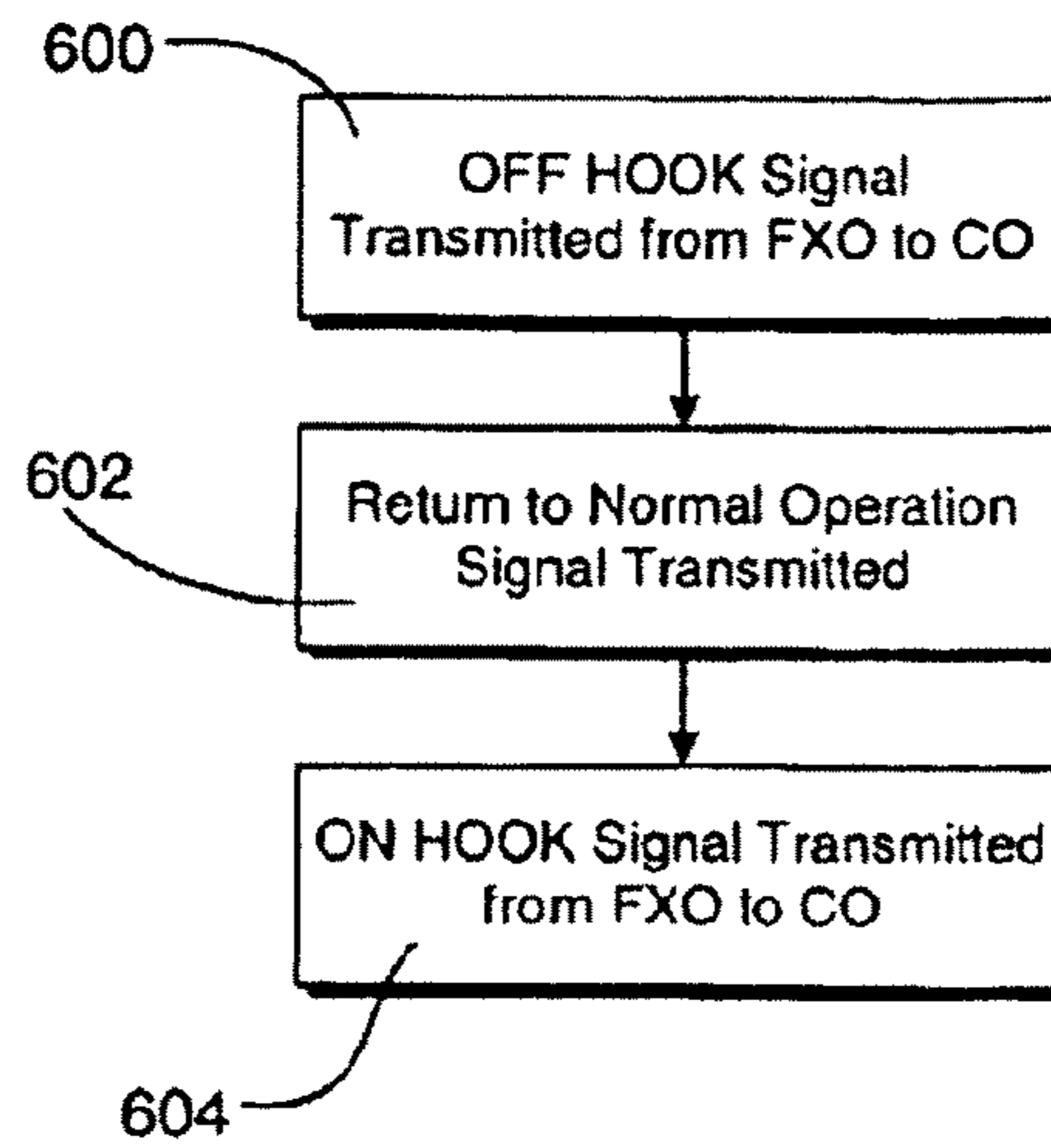


FIG. 7

## RESIDENTIAL GATEWAY FOR VOICE OVER INTERNET PROTOCOL COMMUNICATIONS

### CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation of U.S. Pat. No. 8,228,951, issued Jul. 24, 2012, entitled "METHOD AND SYSTEM FOR PREVENTING DATA LOSS IN A REAL-TIME COMPUTER SYSTEM," which is a continuation of U.S. Pat. No. 7,522,638, issued Apr. 21, 2009, entitled "METHOD AND SYSTEM FOR PREVENTING DATA LOSS IN A REAL-TIME COMPUTER SYSTEM," which claims priority to U.S. Provisional Application No. 60/319,233, filed May 7, 2002, which are hereby incorporated by reference for all purposes.

### BACKGROUND OF THE INVENTION

The present invention relates generally to voice communication systems and, more particularly, to systems for transmitting and receiving voice information over packet-switched networks.

For years, the telecommunications industry has examined was to combine the flexibility and functionality of packet-switched networks primarily used for transmitting data (e.g., the Internet) with the accuracy and speed of conventional circuit based telephone networks (i.e., the Public Switched Telephone Network or PSTN). Conventional telephone systems differ from modern data-based computer networks in several ways. Most importantly however, are the differences in how connections between the sender and the recipient are made.

In conventional telephone systems, when a caller picks up his telephone, an OFFHOOK message is sent from the phone across the PSTN to the user's central office (CO). In response, the CO sends a dialtone back to the user's phone indicated that he is connected and can initiate a call. Next, the caller dials the phone number of the intended recipient and, through the keypad tones or pulses, this information is transmitted to the CO. In response, the CO transmits a RINGING message causing the recipient's phone to ring. If the recipient picks up the phone, the recipient's phone sends an OFFHOOK message to the CO and a dedicated circuit across the PSTN between the caller and the recipient is established, enabling voice traffic to pass between the connected parties in a smooth, seamless manner. Typically, the voice traffic is digitized at the CO and transmitted over the dedicated PSTN circuit using a technology called time division multiplexing (TDM). This dedicated circuit continuously transmits information between the parties at a rate of about 128 kilobits per second (kbps) (64 kbps each way) for the duration of the call. For a five minute telephone call, this equates to the transmission of approximately 4.7 megabytes (MB) of information.

Unfortunately, in most telephone conversations, much of the bandwidth required to enable the transmission of information between the parties is wasted. For example, because people typically do not speak while the other party is speaking, almost half of the available bandwidth is wasted during the call. Similarly, during periods of silence (even milliseconds at a time), no information needs to pass between the parties. However, because of the dedicated, physical circuit between the parties, information is passed regardless of content.

Contrary to conventional telephone systems, most data networks such as the Internet, do not transmit information across dedicated, physical circuits. Rather, information sent

between two computers on a network is broken up in a series of small packets. These packets are then routed to the destination and reassembled at the recipient end. Various protocols have been developed for enabling the efficient and accurate transfer of information across computer networks, such as internet protocol (IP), asynchronous transfer mode (ATM), Ethernet, etc. Because computer networks only transmit the information which needs to be relayed, there is little wasted bandwidth.

Because of the rising need for network bandwidth and the continued need to optimize bandwidth which is already available, efforts have been made to reduce the bandwidth cost of voice traffic by routing voice traffic over packet-switched networks. This concept is generally referred to as voice over packet telephony (, e.g., VoIP), although various other transmission methods and network protocols may also be employed, such as DSL, ATM, or the like. In general, the concept of VoIP requires a seamless experience on the part of the user. That is, conventional telephone systems (referred to as plain old telephone systems or POTS) must be able to utilize the technology in an invisible manner. In practice, similar to conventional PSTN devices, when a POTS device (or analogous customer premises equipment (CPE) device) goes off hook, a message is sent to a CO indicating this state. A dialed number is then received by the CO, indicating the recipient's address, and the corresponding voice traffic is digitized and packetized at the CO for transmission to the recipient's CPE device.

To assist in enabling the effective use of VoIP technology, many CPE devices include support for simultaneous operation of both VoIP and POTS systems. In such a system, a splitter device located at the CO operates to separate received and transmitted signals from the CPE. Upon receipt of an incoming POTS call, signals are first passed through a surge suppressor device which operates to clip the ringing signals. Unfortunately, during ringing on the POTS line, the distortion generated by the surge suppressor is often larger than a transmitted data signal, resulting in a loss of data transmission if a VoIP call is underway during the ringing. Following this disruption in service, it is often necessary to retrain the CPE VoIP system. This process is time consuming (i.e., ~11 secs.) and results in disruption of the outgoing call.

Accordingly, it is desired to provide a method and system for preventing the disruption of VoIP calls caused by concurrent ringing on a POTS line.

### BRIEF SUMMARY OF THE INVENTION

The present invention overcomes the problems noted above, and provides additional advantages, by providing a method and system for preventing data loss in a VoIP system. In particular, during a VoIP call, it is determined whether incoming ringing on a POTS line causes an unacceptable level of signal loss or errors. If so, for subsequent VoIP calls, the CO handling calls to the POTS line is instructed to automatically forward calls to the POTS line to the VoIP line. Calling returns to normal upon ending of the VoIP call. In this manner, incoming ringing on the POTS line does not result in call dropping or lengthy retraining processes.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be understood more completely by reading the following Detailed Description of the Preferred Embodiments, in conjunction with the accompanying drawings.

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FIG. 1 is a block diagram illustrating a telephony system of the present invention.

FIG. 2 is a flow diagram illustrating one embodiment of a method for preventing data loss of VoIP transmissions.

FIG. 3 is a flow diagram illustrating one embodiment of a method for preventing system loss during VoIP transmissions following a determination of unacceptable signal loss.

FIG. 4 is a flow diagram illustrating another embodiment of a method for preventing system loss during VoIP transmissions following a determination of unacceptable signal loss.

FIG. 5 is a flow diagram illustrating one preferred embodiment of step 402 of FIG. 4.

FIG. 6 is a flow diagram illustrating one preferred embodiment of step 410 of FIG. 4.

FIG. 7 is a flow diagram illustrating an additional embodiment of a method for preventing data loss during VoIP transmissions.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring generally to figures and, in particular, to FIG. 1, there is shown a block diagram 100 illustrating a telephony system of the present invention. In particular, diagram 100 includes a first CPE system 102 including surge suppressor 103, a POTS phone 104, and a VoIP phone 106. It should be understood that the CPE systems described herein may be or include any of the following: a telephone, a fax machine, a modem (e.g., digital subscriber line (DSL), coaxial cable, phone), private branch exchange (PBX), or any other integrated access device (IAD) for performing conventional voice system functions or packetization of voice traffic. Likewise, VoIP phone 106 may be any system capable of running real-time packet-based applications and is not limited to either voice applications or the IP protocol. Further, CPE 102 may also include various configurations for splitting DSL and POTS signals, such as modems which include signal splitters, stand alone signal splitters, and data filters for isolating POTS traffic to POTS CPE devices. System 100 also includes a plurality of additional CPE devices 108, 110, and 112 connected over either the PSTN or an IP network.

In operation, each CPE device or system communicates with each other through a central office (CO) system 114, typically operated by an incumbent local exchange carrier (ILEC) and/or a competitive local exchange carrier (CLEC). For conventional analog voice traffic, transmissions pass through a class 5 switch 116 associated with the CO 116 and along to the POTS phone of CPE 102 via a PSTN/VoIP network 118 and through the surge suppressor 103. For DSL or VoIP traffic, voice transmissions pass through a voice gateway (GW) 120 to a DSL access multiplexer (DSLAM) 122 and along to the VoIP phone 106 at CPE 102 via network 118 and also through the surge suppressor. For simplicity, the remainder of this description relates specifically to a system wherein outgoing calls are placed over the VoIP phone 106, while incoming calls are handled by the POTS phone 104, although it should be understood that the present invention may be implemented in any system wherein POTS and VoIP lines are used concurrently.

Because of deficiencies in the design, manufacture and/or operation of surge suppressor 103, the system described above often suffers from non-recoverable data loss on the VoIP line during an incoming call on the POTS phone 104. Essentially, during ringing of the POTS phone 104, a distortion is created in the surge suppressor 103 which is larger in magnitude than the VoIP data being simultaneously transmitted. Consequently, no data is permitted to pass through the

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surge suppressor 103, resulting in delay and potential timing out of the VoIP session. Once the ringing stops, the VoIP CPE 106 must perform a retraining with the CO to establish another VoIP session. This retraining period may take as long as 10-15 seconds, an obviously unacceptable delay when dealing with voice traffic.

Referring now to FIG. 2, there is shown a flow diagram illustrating one embodiment of a method for preventing data loss of VoIP transmissions in accordance with the present invention. In step 200, the CPE device determines whether an unacceptable degree of signal or data loss is suffered when a RINGING signal is received on the POTS line during a VoIP transmission. In step 202, if it is determined that an unacceptable degree of signal loss occurs in such circumstances, the CPE device initiates a process for avoiding the loss preventing the POTS phone from ringing and thereby eliminating the cause of the loss. Additional details of this process will be set forth below.

Turning now to FIG. 3, there is shown a flow diagram illustrating one embodiment of a method for preventing signal loss during VoIP transmissions following determination of unacceptable signal loss in step 202, above. Initially, in step 300, a VoIP call is placed, resulting in the VoIP phone going OFF HOOK. In step 302, a message is sent to the CO which handles calls for the CPE indicating that all calls to the POTS phone should be answered with a busy signal. In step 304 a call is placed to the POTS phone. In step 306, the call is answered with a busy signal by the CO. In step 308, the VoIP session ends and the VoIP goes ON HOOK. In step 310, a message is sent to the CO indicating that operation should return to normal for the POTS phone. In this manner, calls for the POTS phone placed during a VoIP call will not reach the POTS phone and result in a disabling RINGING signal being received.

Turning now to FIG. 4, there is shown a flow diagram illustrating another embodiment of a method for preventing signal loss during VoIP transmissions following determination of unacceptable signal loss in step 202, above. Initially, in step 400, a VoIP call is placed, resulting in the VoIP phone going OFF HOOK. In step 402, a message is sent to the CO indicating that all calls to the POTS phone should be forwarded to the VoIP phone via the CO's GW and DSLAM.

Referring to FIG. 5, there is shown a flow diagram illustrating one preferred embodiment of step 402 above. In particular, in this embodiment, the messages sent to the CO include instructions to the CO's class 5 switch including a combination of a Foreign Exchange Office (FXO) interface and DTMF (Dual Tone MultiFrequency) signals. In step 500, a signal is transmitted from the CPE's FXO indicating to the class 5 switch that the FXO is OFF HOOK. Next, in step 502, the CPE sends a DTMF signal indicating that the switch should prepare to autoforward calls to the subsequent telephone number. In North America, this signal is \*72, however, any suitable signal may be used depending upon the locality in which the system resides. In step 504, the CPE transmits DTMF signals representing the telephone number to forward POTS call to, such as the VoIP phone, although any other telephone number may be used such as the user's mobile telephone. Following entry of the forwarding number, the CPE may wait for a acknowledgment tone if available. In step 506, a signal is transmitted which indicates to the class 5 switch that the FXO is once again ON HOOK.

Returning to FIG. 4, in step 404 a call is placed to the POTS phone. In step 406, the call is automatically forwarded to the VoIP phone by the CO. In step 408, the VoIP session ends and



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the VoIP goes ON HOOK. In step 410, a message is sent to the CO indicating that operation should return to normal for the POTS phone.

Referring to FIG. 6, there is shown a flow diagram illustrating one preferred embodiment of step 410 above. In step 600, a signal is transmitted which indicates to the class 5 switch that the FXO is OFF HOOK. Next, in step 602, the CPE sends a DTMF signal indicating that the switch should return to normal operation. Again, in North America, this signal is \*73. In step 604, a signal is transmitted which indicates to the class 5 switch that the FXO is ON HOOK. From this point on, normal ringing resumes for the POTS phone.

In this manner, calls for the POTS phone placed during a VoIP call will not reach the POTS phone and result in a disabling RINGING signal being received. However, by limiting the POTS restrictions to incoming calls only, outgoing calls on the POTS phone are not affected. Further, by forwarding calls automatically to the VoIP phone, any emergency inbound call to the POTS phone is automatically picked up by VoIP phone. Further, the present invention enables low cost VoIP call forwarding which is local to CO's class 5 switch regardless the physical location of VoIP Phone.

Turning now to FIG. 7, there is shown a flow diagram illustrating an additional embodiment of the present invention. Initially, in step 700, a VoIP call is placed, resulting in the VoIP phone going OFF HOOK. In step 702, the CPE device determines whether any POTS phone connected to the POTS line is OFF HOOK (i.e., one of the POTS phones is currently in use), if not, the CPE takes the POTS line OFF HOOK in step 704, resulting in a busy signal to all incoming calls. If any POTS phone is determined to be OFF HOOK in step 702, the CPE waits until all POTS phones are ON HOOK in step 706 and, in step 708, takes the POTS line OFF HOOK, again resulting in a busy signal to all incoming calls. In a preferred embodiment, this functionality is controllable by the user, thereby enabling emergency calls to the POTS line during VoIP calls.

In an additional embodiment of the present invention, the CPE is configured to not attempt retraining until after the RINGING ends. Since, data transmission is prevented during ringing on the POTS line, system retaining is likewise not possible. By waiting until the ringing stops, the CPE may be able to bypass retraining and go right to data transmission.

In yet another embodiment of the present invention, the CPE is configured to stop notifying the CO about errors it may receive during ringing on the POTS line. If the CPE informs the CO modem about errors and the CO modem is not suffering from errors itself, the CO may request a retrain, thus potentially introducing additional delay. In DMT the CPE uses indicator bits to tell the CO when it is getting errors (CRC, SEF, etc.). Other modems may use similar techniques.

Another manner of preventing data loss during ringing on a POTS line involves configuring the CPE to disable bit swapping between DMT bins. In conventional operation, DMT systems include a plurality of bins corresponding to frequency ranges. When certain bins are determined to be bad by the CPE, it may opt to switch bins to a different frequency range. If this is necessary, the CPE informs the CO that it wishes to swap bins and waits for a ACK signal from the CO acknowledging the switch. Unfortunately, if data is being dropped by a ringing on the POTS line, this ACK signal may not be received, even though it was sent by the CO. Since the CO switches and the CPE does not, the two become out of sync resulting in the need to retrain. By eliminating bit swapping, this source of error can be minimized.

While the foregoing description includes many details and specificities, it is to be understood that these have been

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included for purposes of explanation only, and are not to be interpreted as limitations of the present invention. Many modifications to the embodiments described above can be made without departing from the spirit and scope of the invention, as is intended to be encompassed by the following claims and their legal equivalents.

What is claimed is:

1. A residential gateway for voice over Internet Protocol (VOIP) communications, comprising:

a broadband digital data processor for receiving and transmitting digital data over a network connection and for transmitting a VOIP off-hook signal to a central office; an analog telephone connector for receiving analog voice data;

an integrated access device for performing packetization of the analog voice data to generate first digital encoded telephone signals;

a digital telephone connector for transmitting and receiving second digital encoded telephone signals; and

wherein the broadband digital data processor is for transmitting and receiving the second digital encoded telephone signals and transmitting the first digital encoded telephone signals over the network connection.

2. The residential gateway of claim 1 wherein the broadband digital data processor is for receiving incoming telephone signals originating from an external analog telephone.

3. The residential gateway of claim 1 wherein the broadband digital data processor is for receiving incoming telephone signals originating from a remote digital telephone.

4. The residential gateway of claim 1 wherein the digital telephone connector is for transmitting and receiving VOIP encoded telephone signals.

5. The residential gateway of claim 1 wherein the integrated access device for performing packetization of voice data into VOIP encoded telephone signals.

6. The residential gateway of claim 5 wherein the integrated access device is for performing conventional voice system signaling functions.

7. The residential gateway of claim 1 wherein the broadband digital data processor is for receiving calls from a central office that originate from a remote digital telephone and a remote analog telephone.

8. The residential gateway of claim 1 further comprising: a central office coupled to the residential gateway over a network, the central office for receiving analog telephone signals from remote analog telephone devices and first digital telephone signals from remote digital telephone devices, converting the analog telephone signals from the remote analog telephone devices into second digital telephone signals, and to transmit one of the first digital telephone signal and the second digital telephone signal to the residential gateway.

9. A method for processing voice over Internet Protocol (VOIP) communications at a residential gateway, comprising:

receiving voice data signals at an integrated access device; packetizing the voice data signals to generate VOIP data packets;

transmitting a VOIP off-hook signal to a central switch; transmitting the VOIP data packets over a data network; receiving incoming voice data signals from the data network;

determining whether the incoming voice data signals are for an analog communications device or a digital communications device connected to the residential gateway; and

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transmitting the incoming voice data signals to the analog communications device or the digital communications device.

10. The method of claim 9 wherein receiving the voice data signals at the integrated access device comprises receiving the voice data signals from the analog communications device.

11. The method of claim 9 wherein receiving the incoming voice data signals from the data network comprises receiving VOIP data packets.

12. The method of claim 9 wherein receiving the incoming voice data signals from the data network comprises receiving the incoming voice data signals from a remote analog communications device.

13. The method of claim 9 wherein receiving the incoming voice data signals from the data network comprises receiving the incoming voice data signals from a remote digital communications device.

14. The method of claim 9 wherein transmitting the incoming voice data signals to the analog communications device comprises transmitting analog encoded incoming voice data signals.

15. The method of claim 9 wherein transmitting the incoming voice data signals to the digital communications device comprises transmitting VOIP encoded incoming voice data signals.

16. The method of claim 9 further comprising:  
receiving analog telephone signals from remote analog telephone devices and first digital telephone signals from remote digital telephone devices at a central office;

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converting the analog telephone signals from the remote analog telephone devices into second digital telephone signals at the central office; and  
transmitting one of the first digital telephone signal and the second digital telephone signal from the central office to the residential gateway.

17. A method for processing voice over Internet Protocol (VOIP) communications, comprising:

receiving analog telephone signals from remote analog telephone devices and first digital telephone signals from remote digital telephone devices at a central office;  
converting the analog telephone signals from the remote analog telephone devices into second digital telephone signals at the central office;

transmitting one of the first digital telephone signal and the second digital telephone signal from the central office to a residential gateway;

receiving a response from the residential gateway to the first digital telephone signal or the second digital telephone signal, wherein the response is generated by an analog telephone device and the response includes a VOIP off-hook signal.

18. The method of claim 17 further comprising controlling VOIP communications between the central office and the residential gateway as a function of the response.

19. The method of claim 17 wherein receiving the response from the residential gateway to the first digital telephone signal or the second digital telephone signal comprises receiving packetized voice data from an integrated access device of the residential gateway.

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